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“Exact” algorithm for random-bond Ising models in 2D YEN LEE LOH, ERICA W. CARLSON, Purdue University — For nearly 80 years the Ising model and its variants have given valuable insight into phase transitions and critical phenomena in magnets, alloys, and many other systems. Random-bond Ising models (RBIMs) in particular are often used to study frustration and spin-glass behavior, and they are closely related to neural networks and information theory. We present an algorithm for solving two-dimensional Ising models with any configuration of bond strengths [1]. The algorithm is an extension of the bond-propagation algorithm originally developed for resistor networks [2]. It calculates the partition function and correlation functions at a single temperature for any planar Ising model of linear dimension L in $O(L^3)$ time or less. The results are numerically exact (subject only to roundoff error). The method is especially efficient for dilute models near the percolation threshold, for which it executes in $O(L^2 \ln L)$ time. Moreover, it operates directly in the spin basis, without the need for mapping to fermion or dimer models, and it is massively parallelizable. It gives fresh insight on the peculiar “hidden integrability” of 2D Ising models and suggests new directions for tackling other problems.

[1] Y. L. Loh and E. W. Carlson, to appear in Phys. Rev. Lett. (2006)
[2] D. J. Frank and C. J. Lobb, Phys. Rev. B, 37, 302 (1988).

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